2.3 Bubble Chamber CF_3I Fill Procedure

This procedure covers filling of the bubble chamber inner vessel with its nominal charge of CF_3I. Obviously there is plenty of room to screw up here, hence this is a written procedure.

1) Ensure that the hydraulic pressure cart has been filled and appropriately initialized.

2) Visually check the CF_3I transfer cart and CF_3I transfer plumbing. The cart is equipped with a 25 lb Arlyn Scale that is read out via a 4-20 ma current loop. The CF_3I transfer bottle sits on the balance. The plumbing consists of a flexible connection from the CF_3I transfer bottle to a filter (F-5 and MV-23) and the main Cartan valve (MV-22). The line is equipped with a tee to a vacuum pump down line with an isolation valve (MV-26). The pump down port should be near MV-22.

3) Ensure MV-22 and MV-25 are closed. Open MV-23 and MV-26 and evacuate the CF_3I transfer lines.

4) Ensure that you have the "Commissioning Tool" VI operating. This software will provide access to and logging of all of the state variable data for the chamber, the CF_3I mass transfer data, the control and read-back data from the hydraulic cart and the heater/chiller unit, and photography data for the inner vessel. The goal would be to log data from the initial setup through cool-down, CF_3I distillation, and warm up to normal operating conditions.

5) Initiate data logging.

6) The initial condition is that the inner vessel is filled with water and under vacuum. The pressure vessel has been backfilled with de-gassed propylene glycol. The hydraulic cart is not under pressure.

7) Initiate cool-down[1] to just above 0°C. This will take a while. Follow procedure 2.5 "Bubble Chamber Temperature Ramp up/down" until an appropriate temperature has been achieved and stabilized.

8) Compress (slightly) the chamber. Use the hydraulic piston position controls to drive the fast piston up to near its upper stop. Be very careful not to generate a pressure more than a few psi. It is only necessary to take the slack out of the

[1] The actual temperature is not critical. It needs to be cool enough to maintain the distillation relative to the ~20°C reservoir temperature.

2.3 Bubble Chamber CF_3I Fill Procedure *Written Procedure*

system so that the bellows does not overextend[2] when the inner vessel is pressurized with CF_3I gas.

9) Close MV-26 to isolate the vacuum pump.

10) Open the MV-25 to the CF_3I tank to pressurize the lines.

11) Open MV-22 to initiate the distillation. Over time, one should observe the CF_3I dripping down from above and forming a puddle in the bottom of the vessel. The mass in the tank should continuously decrease.

12) Protect the bellows from overextension by adjusting the position of the inner vessel using the hydraulic cart piston. At the end of the distillation, position the bellows near full extension. With the water originally filled to near the top of the quartz, the vacuum above the bellows had a volume of 800 cm^3. By extending the bellows, an additional 200 cm^3 of volume is made to fit 1 liter of CF_3I into.

13) Allow the distillation to proceed until it stops on its own at the roughly the 1-liter mark.

14) Now iterate to complete the fill:
    a. Estimate the volume of CF_3I required to complete the fill.
    b. Close off the CF_3I inlet valve, MV-22.
    c. Open a purge valve to the inner vessel, MV-21.
    d. Use the hydraulic piston to lift the vessel and drive out your estimated volume, up to 200 cm^3, of water.
    e. Close MV-21.
    f. Open MV-22.
    g. Use the hydraulic piston to expand the bellows and create a new condensation space.

15) On the last iteration, cross-check the mass transfer data, the CF_3I level in the vessel, and the quantity of water removed from the vessel. Make sure you're done.

16) Close off MV-22 and MV-25.

17) *SLOWLY,* pressurize the chamber. Do this by adding compressed air to actuate the fast pneumatic/hydraulic cylinders. Once you've established that the inner vessel is "floating" (i.e. that when all of the CF_3I is condensed the bellows is off its stop) you can run the pressure up to the nominal 200 psig.

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[2] The bellows range, starting from its stop under vacuum, is roughly 200 cm^3. The range of the fast piston is 50 cm^3. Mainly you just need to establish that the hydraulic piston is in fact pushing up on the fast piston, and that there isn't some slack space.

2.3 Bubble Chamber CF_3I Fill Procedure *Written Procedure*

18) Initiate warm up of the chamber to its operating point following procedure 2.5 "Bubble Chamber Temperature Ramp up/down".

19) Terminate data acquisition and secure the data.